The pressure upon a superficial metre, when the wind has a velocity of 50 metres per second, which is that of the greatest hurricanes, is equal to the weight of 275 kilogrammes, or about 336 pounds to the square yard. *Second.* The action of the wind upon a vertical cylinder is reduced to two-thirds of the force which it exerts upon a central vertical section of the same cylinder.

To apply these rules to the stability of a tower composed of a single stone in the form of a right prism with a square base, we should multiply the superficial area of one of its sides by 336 pounds; and this product being multiplied by half the height of the prism, will give the momentum of the wind's force. In order to determine the momentum of resistance, the total weight of the tower should be multiplied by half the width of its base. Dividing this product by the first obtained momentum of the wind, we have the expression of the *absolute stability* of the edifice with regard to the action of hurricanes.

Towers are composed of numerous courses of cut stone, the adhesion of which affects the stability in proportion to the decrease in the size of the blocks of stone used. If we suppose this adhesion to be nothing in a wall composed of courses of stretchers and ties, the fracture caused by the force of the wind will not be horizontal; but (as in retaining walls) according to an oblique section, the inclination of which is determined by the maximum of relation between the force of the wind and the momentum of weight of the solid above the section. But it should be observed that in most high towers, the adhesion of the cement and the arrangement of the materials is such that the section of rupture is less inclined than in ordinary containing walls, and if, in addition to this, we also consider that the results which we seek are of comparison between our tower and those whose stability has been already tested, by having for a long time resisted, without injury, every kind of force; the supposition that the section of fracture would be horizontal should have no sensible influence.

The determination of the section of most easy fracture offers a problem of minimums, the direct solution of which, in general, requires very tedious calculations; but fortunately the position of that section is apparent, in most cases, at the first glance of the eye, or may readily be determined by a few trials.

In case the tower should have the form of a truncated cone, like that of which we are treating, if it should ever yield to the force of the wind, it would be twisted off above the offset of its base, in the direction opposite to that from which it receives the force, and its being broken above the offset would be because the arm of the lever of resistance, instead of being equal to the radius of the section of rupture, is somewhat less.

These principles being established, it is known that, in order to give great stability to a circular wall in ordinary structures, it is sufficient to make the thickness a twelfth part of the height; consequently, having to raise our tower to a height of 80 feet, a thickness of 7 feet was enough for the wall; but as the tower is not an insulated wall, but has within it a circular stairway, which binds and fastens together all its parts, and moreover, as the consideration of a convenient situation for the illuminating apparatus required that the upper part of the tower should be only 20 feet in diameter, we were able to start with 7 feet at the base, and to diminish gradually to four and a half at the top, with the advantage of an exterior slope of two and a half feet in the whole height, which also adds to its strength.

Having established these data, it now remains to examine whether, with these dimensions, the tower possesses as much, or greater, strength than others similar to it, which have been built many years, and have resisted, without the least damage, the force of the greatest storms, and I say it ought to be stronger; 1st. Because the terms of the comparison which we seek are derived from towers built in Europe, where hurricanes are neither so frequent nor of such long duration as in the Antilles; and, 2nd. Because the tower which we have constructed, from its peculiar situation has to sustain not only the force of the wind but the shock of the waves, although this is somewhat diminished by the tower being placed twenty-two yards above the level of the sea.

For comparison, we will take the signal tower erected in 1715, at the port of L'Orient, the form of which is similar, on the whole, to that constructed at the Moro, and which has withstood, until the present time, without injury, all the force of the storms.

Stability of the Tower at L'Orient.—The result of a calculation with regard to this tower shews that the relation of the resistance to the pressure is 7·4; that is to say, the resistance is 7·4 times greater than the pressure. Let us now see what result will be obtained by an analogous calculation with regard to the tower at the Moro.

Calculation of the Stability of the Tower at the Moro.—The content of the truncated cone which constitutes the lower part, is 31,174 cubic feet. The interior cylinder, which contains the staircase, is 11 feet in diameter and 34½ in circumference; the area of its base, 95 square feet; and its content, $95 \times 78 = 7410$ cubic feet. Taking this from the total solid content, there remain 23,764 cubic feet for the solid content of the circular wall of the lower part of the tower. The cylindrical column in the centre of the circular stairway contains 450 cubic feet, and the stairway itself 306; so that the total solidity of the masonry in the lower body of the tower is 24,520 cubic feet, or 908 cubic yards. Adding to this 3 cubic yards for the projection of the cornice, and subtracting 36 yards for the apertures left for doors and windows, there remain 875 cubic yards of masonry. As the attendants' room, in the lower section of the tower, is a foot larger in diameter than the interior space occupied by the stairway, it follows that the amount of masonry, which on this account has been rather over-estimated, will be made up by the arched ceiling of this room, which has not been taken into the account.

The solid content of the circular wall which forms the upper section of the tower, upon which the lantern is placed, is 27 cubic yards, deducting the opening for the door; so that the whole amount of solid masonry is 902 cubic yards.

A cubic yard of the masonry used in this tower weighs 85 arrobas (25 pounds each), and the arm of the lever of resistance being 4 yards (a little less than the radius of the base), it follows that the power of the resistance will be $902 \times 4 \times 85 = 306{,}680$.

A central perpendicular section of the lower portion of the tower contains 195 square yards; of the upper portion, 13; and of the lantern, 26; presenting a total sectional superficies of 234 square yards. The centre of gravity of these three superficies is found at 13 yards from the base of the tower; consequently, the momentum of pressure from the wind is $\frac{1}{2} 336 \times 234 \times 13 = 31{,}504$ arrobas, and the ratio of the resistance to the pressure

$$= \frac{306{,}680}{31{,}504} = 9\,7,$$

By this result it will be seen that the tower at the Moro has a stability equal to nearly one and a half times that of the tower at L'Orient, which was taken for comparison, and consequently that its dimensions are sufficient, although indispensable for the reasons already mentioned, to warrant the undertaking of its construction with entire confidence.

Details of the Construction.—Foundation.—As the tower is 25 feet in diameter at its base, a circle 28½ feet in diameter was traced around the centre of the area to be occupied by it; so that the excavation for the foundation being larger than the body of the tower, a berm, or offset, of 21 inches, would be left by the extension of the foundation wall beyond that of the tower itself. The excavation was carried through the surface soil down to the rock which underlies the glacis of the Morillo, which was reached and laid bare at an average depth of 15 feet.

The rock presented an irregular surface, in consequence of which, together with its extreme hardness, the operation of cutting it down to a level would have been very expensive. It was therefore deemed preferable to construct the foundation by steps (*en escalones*), using blocks of stone of the best kind, disposed in circular horizontal layers (*formando anillos en capas horizontales*), properly placed, and the joints filled with a mixture of lime and sand; taking care, as in all masonry of hewn stone, that the joints of each layer should be covered by the course immediately above it.

The foundation is 9½ yards in diameter by 5 in depth, and consequently contains 355 cubic yards of masonry. The cost of its excavation and refilling was 1,554 dollars, being 4·375 dollars per cubic yard.

The lower part of the Tower.—Upon the level top of the basement, or foundation, the first layer of stone forms a solid floor over the whole, 25 feet in diameter; its outer border being vertical and forming a projection or socle of 9 inches around the tower, as well as a step of the same height, for entrance into it. The building is then continued to the requisite elevation by successive courses of 18 inches in height. In order to give an exterior slope to the wall, and consequently to diminish its thickness in due proportion, the width of the blocks in the interior courses was gradually contracted, while those on the exterior were continued of the same breadth, so that the vertical joints might recede gradually towards the interior, and the masonry be well united together; thus avoiding the defect which would result from an equal diminution in the breadth of the blocks used in both the inner and outer faces of the wall, in which case, the vertical joints of each course would continue to be one above another, thus forming two distinct walls, without further connection than that of the extending ties.

The circular stairway is composed of entire blocks of stone, which are inserted six inches into the wall, each of them forming two steps, together with the corresponding part of the central column, or nave, of the staircase. It was carried up at the same time with the wall of the tower, in order to insure the proper connection and binding together of the work, and also served for use during the construction of the building; the order of proceeding being first to set the block of stone which formed two steps, and then to lay the corresponding course on the wall, and so on successively.

In the dome which covers the attendants' room, the precaution was taken, in order to avoid the least displacement, to fasten all the arch stones of the second and third courses, together with those of the first, with iron clamps, one and a half inches thick by three inches wide, let into the arch stones and fastened to each of them by a bolt, which passes through two-thirds of their thickness, well secured with lead.

Materials.—The stone used in the construction of the tower was taken from the quarries known here by the name of *playa de chivos*, immediately at the point where the tower stands, and preferable to the stone found at any other place in the vicinity, because, although not of the hardest quality, they are still sufficiently so, and of a more equal and homogeneous texture than the others.

The lime and sand employed were both of excellent quality; the former made of a very hard and clean stone, and the latter containing no saline matter. The mortar was made with great care, composed of two-fifths of lime and three-fifths of sand, mixed with fresh water and well stirred, so as perfectly to incorporate the ingredients.

After the completion of the edifice, in order to preserve it from the effects of moisture and of nitrous salts, inasmuch as the stone, as already stated, is not of the hardest kind, it was covered, both on the interior and exterior surface, with a very thin and well laid coat of painted stucco.

MASTERS AND SERVANTS.—In Birmingham, last week, the assistant of a photographist brought an action to recover wages due. He had agreed with defendant "to work for and serve him diligently and truly, in the photographic art, for the term of three years, from the 24th of July, 1846, at a salary of three guineas per week;" and in the agreement was also a clause, that the said plaintiff "should not work for any other person or persons during that period." It was proved that he had in his over-time taken portraits on his own account; and the judge decided that he could not recover, inasmuch as by law his master was entitled to his whole services, and he was not at liberty, during the continuance of the agreement, to take portraits for himself and receive the money for them, or for any person other than his master; and that by doing so he was in fact enticing away the customers of his employer, to his manifest injury.

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